Independent peer review of the Common Thresher Shark (*Alopias vulpinus*) stock assessment off the west coast of North America.

conducted for

The Center of Independent Experts

by

Joseph E. Powers

Encompassing Evaluation of Research Documentation, Participation in Review Meeting at NOAA/NMFS Southwest Fisheries Science Center in La Jolla, California from 26-28, June 2017

and

Report Preparation

September 2017

Executive Summary

The current assessment of Common Thresher Shark off the west coast of North America (as amended at the Review Meeting) represents the best available data for that stock.

While the stock experienced high catches in the past, resulting in depleted stock size, recent decades of low exploitation has allowed the abundance to increase substantially. As such, in my scientific opinion, the stock abundance is larger than that which could support MSY and low recent catches (<200 t) indicate fishing intensity less than that at MSY.

There were important uncertainties in the assessment data (and subsequently the modeling), but these do not change the basic conclusions about stock status. The status is well below fishing rate limits and well above abundance limits. However, the uncertainties affect the precision of the estimates of the biological reference points.

The primary uncertainties lie with the basic life history and reproductive information: maturity, gestation, resting periods, pupping rates and spatial areas at various life stages. Research addressing these aspects should be very useful.

Background Section

The Fisheries Resources Division (FRD) of Southwest Fisheries Science Center (SWFSC) requested an independent review of the benchmark stock assessment developed for the Common Thresher Shark (*Alopias vulpinus*) stock along the west coast of North America. This was the first stock assessment of this resource that incorporated information from all fisheries exploiting the population.

In response to the FRD request, the Center for Independent Experts (CIE) was requested to complete the independent review. CIE reviewers included myself (Dr. Joseph Powers, USA), Dr. Rui Coelho (Portugal) and Dr. Henrik Sparholt (Denmark).

My role in this review was to evaluate background information including the draft stock assessment and biological research results (Appendix 1), participate in a review meeting, assist in preparing a summary report of that meeting and to provide a report of my conclusions and recommendations pertaining to the thresher assessment and research. The details of the terms of reference for my tasks are given in the Statement of Work in Appendix 2. But essentially, I was requested to provide my scientific opinion as to whether the assessment was the "best available data" and for technical comments on the factors affecting uncertainty associated with the assessment. This report represents my scientific findings on the matter.

The Stock Assessment Review was held at NOAA/NMFS Southwest Fisheries Science Center in La Jolla, California from 26-28 July 2017 to review the stock assessment. The meeting was open to the public; however, there was no public participation. Attendees at the meeting along with their affiliations are listed in Appendix 3.

The biological range of the stock spans the west coasts of Mexico, the United States of America (USA), and Canada. The common thresher shark fisheries of the USA and Mexico are managed through the Pacific Fishery Management Council (PFMC) and the Instituto Nacional de Pesca (INAPESCA), respectively. There have been no fisheries for common threshers along the west coast of Canada or in international waters that target common thresher sharks and bycatch is probably not significant.

Fisheries in both the USA and Mexico have declined substantially since the start of commercial fisheries for this stock in the late 1970s, with total removals estimated to be <200 t in 2014. The decline in catch is associated with large declines in fishing effort. For example, currently there are fewer than 10% of the vessels participating in the US drift gillnet fishery as compared to the early 1990s.

The current USA fishery management plan for this stock of common thresher sharks includes a harvest guideline of 340 t based on an unpublished analysis of USA data and is derived from the optimum yield for vulnerable species, which is defined as 0.75*MSY (or reasonable proxy). No management actions have been taken that are solely directed at threshers, but indirect effects of regulations on the fishing gear used has definitely affected fishing behavior relative to thresher exploitation.

The Stock Synthesis (SS) modeling platform was used to conduct the analysis. The model began in 1969, assuming the population was at equilibrium prior to 1969 in a near unfished state, and ended in 2014, which was the last year that data was available.

Summary of findings for the *Status of common thresher sharks, Alopias vulpinus, along the west coast of North America* for each TOR in which the weaknesses and strengths are described

TOR-1. *Evaluate the assessment model configuration, assumptions, and input parameters (e.g., natural mortality, spawner-recruit relationship, reproductive biology) to determine if the data are properly used, input parameters are reasonable, models are appropriately configured, assumptions are reasonably satisfied, and primary sources of uncertainty are accounted for.*

Catch Data

As always, some assumptions had to be made on the catch history, especially in the initial years when there were few details in species-specific catches. In general, the work that was done seems adequate to reconstruct the catch series of the fishery. There were some questions about catches from small artisanal Mexican fishing boats (about 2,000) the majority of which do not have licenses to fish for threshers, but might be still catching sharks. However, the catch estimates were derived from market sampling in addition to port-sampling. Thus, if there were significant unreported removals, then they would have had to have been discards, which is unlikely. Therefore, the catch data is the best available.

CPUE standardization

Usual (and common) CPUE standardization methods were used, i.e. GLM models using the Delta lognormal approach. It is especially used when part of the data is composed by zeros, as is the case of the CPUE datasets analyzed.

There may be alternatives in which the discrete nature of these data may be maintained through the standardization process by using a discrete distribution like a negative binomial (which allows zeros). At the assessment review meeting, a more general alternative was suggested: a Tweedie distribution (generalization of the exponential family) that can model the mass of zeros and the continuous component for the positives in the same model. I, personally, am not familiar with this (although I looked it up after the meeting). Perhaps, this can be looked at.

Perhaps the biggest difficulty with the indices was that the index from the main gillnet fishery was required to be truncated into three time blocks because of changes in regulations and a period of missing information. This means that there is more uncertainty in the large fish trends which has ramifications as noted below. Perhaps, an attempt could be made for the entire time series combined, trying to account for the changes in management regulations (mainly seasonal and spatial closures), but I am not optimistic.

Finally, the issue of targeting was considered. The targeting variable used ranking of the swordfish catches within each year. However, if there were consistent fishing strategies within a

year affecting both swordfish and thresher, then this may skew the standardization. Perhaps, year-targeting interactions could be evaluated in the future.

Natural Mortality M and Reproductive Biology

There are significant uncertainties in the basic biology of this thresher stock. Natural mortality rates and reproductive biology were major sources of uncertainty in the stock assessment. In the original assessment, the size (age) of maturity was relatively small and the reproductive biology assumed four pups per year for an annual reproductive cycle (four pups per year per mature female each and every year). However, subsequent further examination of the research suggests that productivity might be lower, i.e. size at maturity is larger and perhaps a two-year reproductive cycle. This was based on comparison with Atlantic stocks and due to evaluation of the original Pacific research (perhaps misidentification of common threshers as pelagic threshers, misunderstanding of measurement units of length). I accept the new working hypothesis (larger size at maturity and possibly a biennial reproductive cycle).

This change implies a change in the perception of natural mortality rates, as expected. In order for the stock to persist under the assumed reproductive biology, natural mortality would have to be lower than M=0.14 for all ages post-recruitment. The model was unable to converge with natural mortality rates this high. Model tests with lower M's converged, but implied higher longevity. I accept that the M's are probably lower than originally specified and that longevity is larger. Ultimately, the M value specified was 0.04 (discussed further below).

Stock-Recruitment

The stock recruitment model chosen for use in the common thresher assessment was that of Taylor et al. (2013). This model is essentially a modification of a Ricker function with an additional term, β, which defines the strength of the depensation effect at larger stock sizes. Additionally, the particular parameterization allows for the use of basic reproductive information more directly in the specification of the slope of the stock-recruitment curve at the origin. The parameterization used was:

$$R_y = B_y exp\left[-z_0 + (z_0 - z_{min})\left(1 - \left(\frac{B_y}{B_0}\right)^{\beta}\right)\right]$$

where recruitment R in year y is in number of pups, B_y is the number of pups born at the beginning of the recruitment process in year y (B_0 denotes equilibrium pup production when there is no fishing and $S_0=R_0/B_0$ is the equilibrium survival when there is no fishing which is calculated using life history information: natural mortality rates at age, fecundity (number of pups) and age of maturity. Additionally,

$$z_{min} = z_0(1 - z_{frac}) = z_0 - z_0 z_{frac} \qquad z_0 = -ln(S_0) \quad z_0 - z_{min} = z_0 z_{frac}$$

and z_{frac} is a fraction ranging from 0 to 1. Hence, knowing S_0, B_0, z_{frac} and β completely defines the function. The steepness of this functional form is:

$$h = 0.2exp\left[z_0 z_{frac}\left(1 - 0.2^{\beta}\right)\right]$$

although steepness is not a particularly relevant metric for this model.

The above form may be reparameterized into:

$$R_y = S_0^{1-z_{frac}} B_y exp\left[-\frac{1}{\beta}\left(\frac{B_y}{B_0}\frac{B_o}{B_{max}}\right)^{\beta}\right] = \left(\frac{R_0}{B_0}\right)^{1-z_{frac}} B_y exp\left[-\frac{1}{\beta}\left(\frac{B_y}{B_{max}}\right)^{\beta}\right]$$

where B_{max} is the number of pups at birth that produces the maximum number of surviving recruited pups. I believe this form shows the significance of the parameter choices better than the original form. Note that if β=1, then this form is a Ricker function.

The fraction z_{frac} functions similarly to the steepness parameter of more commonly used Beverton-Holt stock-recruitment models. It defines the slope of the S-R curve at the origin, i.e. the maximum recruitment rate that can be produced when stock sizes approach zero (slope at origin = $S_0^{1-z_{frac}}$). And similar to steepness specifications, there was little information in the data to determine z_{frac} and, thus, alternatives were explored in the assessment through sensitivity analyses.

There was not a strong biological hypothesis for how depensation was occurring in common thresher to support the choice of a Ricker-like form, other than it was originally applied to a shark species. Also, there was not an argument presented as to why hyper-depensation ($\beta > 1$) was occurring. Additionally, it was noted that similar to most fish stocks, the assessment model assumed that all density-dependence in common thresher over their lifespan occurred in the few months after their birth. In most fish stocks, this is a reasonable assumption. But, perhaps there are other stages in a shark's life where density-dependence can occur (nursery areas?). For example, the differential equation defining a Ricker recruitment process contains a density independent mortality rate that acts continuously during the recruitment period *and* an *instantaneous* density-dependent factor (Brooks and Powers 2007. ICES Journal of Marine Science, 64: 413–424) as compared to a Beverton-Holt process where density-dependence occurs throughout the period. So perhaps, congregation of predators in an area where pups are born might be a mechanism to induce a Ricker process. This supports the need for more basic research on reproductive biology and life history.

The final base case estimated stock recruitment model is described in Figure 1.

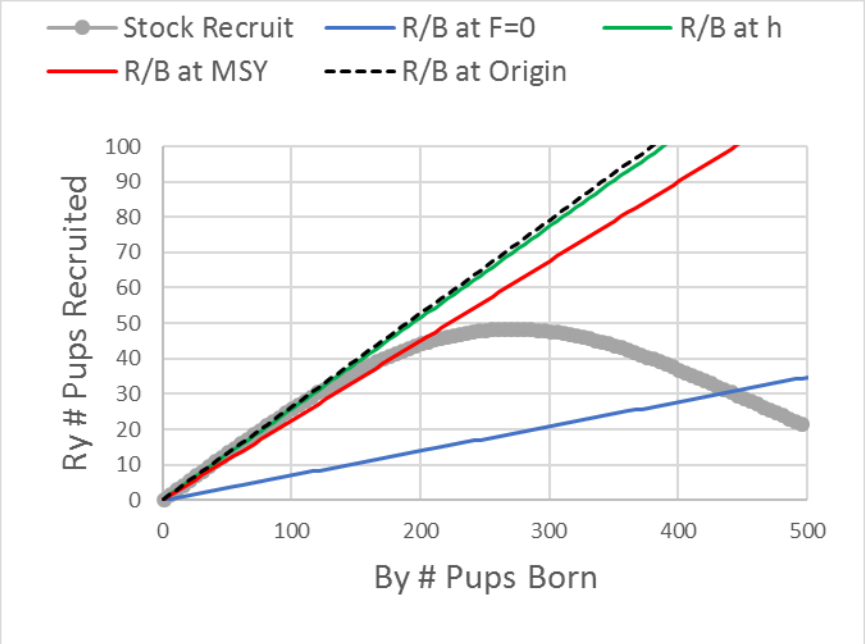

Figure 1. Final base case S-R curve with various replacement lines (R/B's). $S_0 = R_0/B_0 = 0.069$; β=2.53; $zfrac$=0.5; B_0=439.9; B_{msy}=203; B_{max}=271; $S_0^{1-zfrac}$ = slope at origin = 0.264; steepness h = 0.74

Other forms of the stock-recruitment function could have been explored, which would have the same effect of rapid declines when the stock size was low. One example might be a basic hockey stick model where the recruitment is constant over stock size until it reaches a threshold at which it declines linearly to the origin. A hockey-stick model is not meant to be biologically realistic, but rather it is a pragmatic test of the effects of a stock-recruitment relationship whereby declining stocks size (# pups) reaches a threshold at which recruitment declines rapidly and near-linearly to the origin. I believe that the Ricker-like form that was chosen displays these same characteristics at lower # pups produced. This model and others would likely have produced similar results. And any function with steep declines at low stock sizes would be compatible with shark life history. I believe that the resulting dynamics of common thresher stock-size over the years and basic status of the stock is relatively robust to the functional form chosen.

Interplay between M, S-R and Reproductive Biology

Note that the reproductive biology and M define the parameter $S_0 = R_0 /B_0$ of the S-R curve. And then z_{frac} is used to define the slope at the origin of the S-R curve.

Several test runs were made with M=0.08 and z_{frac}=0.8 and alternative inclusions of index data. But, removing the S4 and S5 indices from the model gave a very different stock trend over the recent years, with very low stocks sizes compared to keeping these indices in the model. M had to be reduced to 0.04 and Z_{frec} to 0.5 before these inconsistencies vanished. Ultimately, I agree that the basic uncertainties in the biology cause some inconsistencies with the data. Therefore, in order to provide the most robust management advice, the assessment model should compromise

on the biology and provide the best statistical model. Implicitly, this is analogous to using a simpler regression model for use in interpolating data. However, as with simple regression, a pragmatic model is more suspect when projecting outside the range of the data. Thus, I agree with the base solution, M=0.05 and z_{frac}=0.5. But as noted, the major uncertainty is the interplay between M, reproductive biology and the S-R curve.

An implication of the stock-recruitment results and of shark life histories, in general, is that there is little surplus in recruitment to be taken as yield as the fish get older (Figure 1). While an MSY-related stock size is calculated, the results indicate that small increases in fishing mortality above that at MSY could result in rapid declines in stock size. In other words, stock size at MSY is on the declining slope on the left side of the S-R curve. This suggests caution in implementing an MSY target as an objective.

TOR-2. *Evaluate the ability of the model, combined with available data, to assess the current status and productivity of common thresher sharks along the west coast of North America.*

Stock Status

The assessment is relatively robust in showing that stock sizes declined in the early years while experiencing high catches. When catches were reduced, the stock recovered. The degree and timing of recovery are heavily dependent on uncertainties in reproductive biology and life history characteristics. The assessment choices made by the assessment team, the Review Committee including myself opted for statistical fits to the data, recognizing the apparent uncertainty in natural mortality rate, gestation, reproductive cycle. Nevertheless, I am confident that the current fishing rate is well-below MSY-related fishing limits and stock size is above limits established in the US management system.

The base-case model indicates

Number Adult Females in 2014	136,800
Number Adult Females at MSY	101,500
Number Adult Females at *MSST	97,440
Fishing Intensity (1-SPR ave 2012-14)	0.10
Fishing Intensity (1-SPR at MSY)	0.45
Catch in 2014	~160t
MSY	718t

*MSST is Minimum Stock Size Threshold = (1-M) x stock size at MSY, where natural mortality rate M is specified as 0.04. MSST is the stock size at which an overfished stock exists and a recovery plan must be implemented.

Therefore, common thresher is not overfished in that the adult female stock size is greater than that at both MSY and MSST, and the stock is not undergoing overfishing because current fishing intensity is less than that which would produce MSY.

However, uncertainties in life history, reproductive biology and the ensuing implications for the stock-recruitment relationship are large. Therefore, projections of stock size using the current assessment and stock-recruitment model will be extrapolating beyond the data and will also be very uncertain. While I am confident that the stock is not currently overfished or undergoing overfishing, there is less certainty about catch strategies that would be required to achieve MSY. If management were to pursue a policy of something close to MSY, then the ability to precisely determine the strategy to achieve this is severely limited by uncertainties in basic biological information as, noted above. But, under current catch policies, the status is robust.

The basic catch, size frequency, and CPUE index data indicate that previously there were large catches, the stock and recruitment declined and then with the large reduction in catches the stock increased. This is the common-sense conclusion drawn from the assessment. However, the adult fish CPUE index is not particularly strong, so it does not constrain the stock recruitment-M-reproductive cycle-maturity interplay very much. For example, for longer reproductive cycles, later maturity result in scenarios in which the stock recovery has been slower than the base model. Additionally, the depensation aspect of the S-R model means that as B surpasses B_{max} on its way to B_0, then recruitment declines. This also leaves a perception of a slower recovery rate.

It is also noted that MSST and MSY stock size may not be particularly precautionary for this shark species. Generally, MSST is specified to allow some flexibility if stock size declines below that at MSY before a more rigorous management response is initiated. However, the stock sizes at both MSST and MSY for common thresher are both on the declining slope of the stock-recruitment curve at lower stock size. This further suggests that if a true MSY policy were to be pursued, additional biological information is needed to be able to preciously determine that policy.

TOR-3. *Evaluate the adequacy of sensitivity analyses to represent the main axes of uncertainty in the assessment.*

The main sources of uncertainty are the result of the interplay between natural mortality rates, reproductive cycle, and life history. This manifested itself in the model in the stock-recruitment function. Several model runs were made both prior to the meeting and at the meeting itself. This primarily focused on # pups per year, M, z_{frac}, β, size of maturity and various combinations of inclusion and exclusion of indices of abundance. As noted above, while the index and size frequency data are not overly strong, they are sufficient to provide robust management advice. The weakness is in the basic biology. This was demonstrated through the sensitivity analyses.

TOR-4. *Recommendations for future research priorities and further improvements to the assessment model.*

Size samples were adequate from some fisheries but very limited in others, especially for the US recreational and Mexican commercial fisheries. The limited nature of the available data contributes to the uncertainty in (primarily) the selectivity functions estimated. Better size/sex frequency sampling could provide more precision on adult and juvenile abundance.

The survey design and protocols of the USA juvenile thresher shark survey should be re-examined and improved.

CPUE Standardization: while the standardization methods used were commonly acceptable throughout fisheries assessments, alternatives might be explored which maintain the discrete nature of the data (in numbers rather than weight). Also, issues of targeting (what criteria used for defining "targeted" thresher effort) and perhaps incorporating regulatory changes directly into the CPUE model would be useful. By doing so, the result would be indices over a longer time period with better precision.

By far the most important research direction for improving the assessment is understanding the life history and reproductive biology of these sharks. These aspects critically affect our perception of natural mortality rates and the choice and parameterization of the stock-recruitment function and the basic productivity of the population. These in turn define MSY management criteria and overfishing and overfished limits. Some issues are:

> Where do the fish go during life stages? Is all density-dependence occurring immediately after birth? Or are there nursery areas where predation may be density-dependent? What is the reproductive cycle; is there a resting period after gestation? What is the age of maturity? As such, it is highly recommended to continue the biological studies to further investigate the reproductive biology of this population, especially in terms of the size at maturity, age at maturity, and reproductive cycle/periodicity.

These results will lead directly into the stock-recruit relationship. As for the stock-recruitment functional relationship chosen, there should be further examination of biological reasons for this form (especially β). At this point in time, that choice is not critical to the scientific conclusions. But in the future, this may be important.

TOR-5. *Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations*.

My review took place in three phases. First, I was provided several background documents (original assessment, update, biological research reviews). Then, I participated at the Review Meeting in La Jolla. Finally, after the meeting, I re-reviewed the available evidence and prepared a report (herein) of my findings.

The background documents were provided with adequate time to review them. They were also, understandable, i.e. the written documentation of the modeling and research were clear and concise.

The meeting itself was collegial and useful. Presentations were made to assure understanding of the process. The focus of much of the meeting was to examine diagnostics of the modeling, suggest alternative structures/sensitivities that were tested with the SS platform, then these were

re-examined. Suggestions were made by both the meeting group, as well as the reviewers. The give and take provided me with adequate information to base my scientific opinion.

Subsequent to the meeting, SWFSC staff responded to further information requests rapidly. And there was adequate time to prepare the required report.

Because the background documents were available, and because SWFSC staff was available to run alternative sensitivities, the review process worked well.

I have no recommendations for improvement.

Conclusions and recommendations in accordance with the TORs

My conclusions and recommendations are essentially those expressed in the Executive Summary:

> The amended assessment is the best available data; the stock is neither overfished nor undergoing overfishing.

While these conclusions are robust, basic uncertainties remain due to limited understanding of the life history and reproductive biology. Therefore, I recommend that if improvement is desired, then research programs be continued and/or initiated to address reproductive cycle, critical life stages and maturity ogives, and how they interact with natural mortality rates and the stock-recruitment function.

Additionally, normal fisheries data: size frequencies and indices of abundance and their standardization might be improved by the combination of increased sampling of sizes, more designed resource surveys and refinements in the targeting definition for CPUE standardization.

Appendix 1: Bibliography of materials provided for review

Anon. 2017. FAQs: West Coast drift gillnet (DGN) fishery & protected species. U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, West Coast Region.

Aryafar, Helena; Preti, Antonella; Dewar, Heidi; and Kohin, Suzanne. 2017. Re-examination of the reproductive biology of common thresher sharks along the west coast of North America. Fisheries Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA.

Romanov, Evgeny. 2015. Do common thresher sharks *Alopias vulpinus* occur in the tropical Indian Ocean? IOTC Working Party on Ecosystems and Bycatch (WPEB) Olhão, Portugal.

Taylor, I. G., V. Gertseva, R. D. Methot, and M. N. Maunder. 2013. A stock-recruitment relationship based on pre-recruit survival, illustrated with application to spiny dogfish shark. Fisheries Research, 142: 15-21.

Teo, Steven L. H.; Rodriguez, Emiliano Garcia; and Sosa-Nishizaki, Oscar. 2016. Status of common thresher sharks, *Alopias vulpinus*, along the west coast of North America. NOAA-TM-NMFS-SWFSC-557.

Teo, Steven L. H. 2017. Population dynamics of common thresher sharks along the West Coast of North America, assuming alternative reproductive biology and natural mortality parameters. Fisheries Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA.

Appendix 2.

Statement of Work

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Center for Independent Experts (CIE) Program

External Independent Peer Review

Status of Common Thresher Sharks, *Alopias vulpinus*, along the West Coast of North America

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf). Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

The Fisheries Resources Division (FRD) of Southwest Fisheries Science Center (SWFSC) requests an independent review of the benchmark stock assessment developed for the common thresher shark stock along the west coast of North America. The biological range of the stock spans the west coasts of Mexico, the United States of America (USA), and Canada. The common thresher shark fisheries of the USA and Mexico are independently managed by the Pacific Fishery Management council (PFMC) and the Instituto Nacional de Pesca (INAPESCA), respectively. However, there are no current nor historical fisheries along the west coast of Canada and in international waters that target common thresher sharks and bycatch appears to be rare. Common thresher shark fisheries in both the USA and Mexico have declined substantially since the start of commercial fisheries for this stock in the late 1970s, with total removals estimated to be <200 t in 2014. The current USA fishery management plan for this stock of common thresher sharks includes a harvest guideline of 340 t based on an unpublished analysis of USA data and is derived from the optimum yield for vulnerable species, which is defined as 0.75*MSY (or reasonable proxy).

This is the first stock assessment of common thresher sharks along the west coast of North America that incorporates information from all fisheries exploiting the population. The Stock Synthesis (SS) modeling platform was used to conduct the analysis. The model began in 1969, assuming the population was at equilibrium prior to 1969 in a near unfished state, and ended in 2014, which was the last year that data was available. The stock assessment considered this population to be a single, well-mixed, trans-boundary stock and relied heavily on data from both the USA and Mexico. However, it is important to note that the analysts who reconstructed the catch time series for Mexico's fisheries will not be available for the peer review. A key uncertainty highlighted in the stock assessment is the reproductive biology of this stock of common thresher sharks. Previous research on this stock of common thresher shark suggested that female sharks had an age of maturity of 5 years of age and an annual reproductive cycle. However, a recent study on the reproductive biology of the western North Atlantic stock of common thresher sharks demonstrated a much older median age of maturity (age-12) and longer reproductive cycle (biennial or triennial cycle). Sensitivity model runs indicated that changing the maturity and fecundity schedules resulted in substantial differences in the trend and scale of the estimated population dynamics. The stock assessment provides the basis for scientific advice on the status of common thresher sharks along the west coast of North America. An independent peer review of the assessment is therefore essential. The Terms of Reference (ToRs) of the peer review and the tentative agenda of the meeting are below.

Requirements

NMFS requires a review chair who has a working knowledge and recent experience in the application of fisheries stock assessment processes and two (2) reviewers to conduct an

impartial and independent peer review in accordance with the SoW, OMB guidelines, and the ToRs below. The Chair would ensure that reviewers understand the importance of the peer review process in accordance with the SoW, OMB Guidelines, and ToRs. In addition, the chair will be selected by the contractor and be responsible for facilitating the meeting.

The CIE chair shall serve as an external expert to chair the panel review and have excellent oral and written communication skills. In addition, the chair shall a have working knowledge, recent experience in the application of fisheries stock assessment processes, and results, including population dynamics, integrated statistical age-structured models like Stock Synthesis models and shark biology (reproduction and growth). The chair should also have experience conducting stock assessments for fisheries management.

The reviewers shall also have working knowledge, recent experience in the application of fisheries stock assessment processes, and results, including population dynamics, integrated statistical age-structured models like Stock Synthesis models and shark biology (reproduction and growth). They should also have experience conducting stock assessments for fisheries management. It is desirable for at least one of the reviewers to be familiar with shark stock assessments.

Tasks for reviewers

1) Review the following background materials and reports prior to the review meeting;

Teo, S. L. H., E. G. Rodriguez, and O. Sosa-Nishizaki. 2016. Status of common thresher sharks, *Alopias vulpinus*, along the west coast of North America. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFSC-557. 196 pp.

Aryafar, H., A. Preti, H. Dewar, and S. Kohin. Reproductive biology parameters for common thresher sharks along the west coast of North America. Document to be developed.

Stock Synthesis model files and other related assessment information published in the interim that is provided by the SWFSC Project Contact.

2) Attend and participate in the panel review meeting. The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to answer any questions from the reviewers, and to provide any additional information required by the reviewers.

3) After the review meeting, reviewers shall conduct an independent peer review report in accordance with the requirements specified in this SoW, OMB guidelines, and ToRs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.

4) Each reviewer should assist the Chair of the meeting with contributions to the summary report.

5) Deliver their reports to the Government according to the specified milestones dates.

Specific Tasks for CIE Chair:

The following chronological list of tasks shall be completed in a timely manner as specified in the **Schedule of Milestones and Deliverables.**

1) Conduct necessary pre-review preparations, including the review of background material and reports in advance of the peer review;

2) Participate as the chair during the June 26-28, 2017 panel review meeting at the Southwest Fisheries Science Center in La Jolla, California, and facilitate the panel review maintaining the focus of the peer review in accordance with the ToRs;

3) Produce a Summary Report of the proceedings. The summary report shall not be a consensus report. The independent CIE reviewers should have an opportunity to review and provide comments or elaboration on any points raised in the summary report that they feel might require further clarification.

Foreign National Security Clearance

When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be at the contractor's facilities, and at the Southwest Fisheries Science Center in La Jolla, California, USA.

Southwest Fisheries Science Center
Pacific Room
8901 La Jolla Shores Drive
La Jolla, CA 92037
USA

Period of Performance

The period of performance shall be from the time of award through August 18, 2017. The CIE chair and each reviewer's duties shall not exceed 14 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms CIE Chair and reviewers
No later than June 5, 2017	Contractor provides the pre-review documents to the CIE Chair and reviewers
June 26-28, 2017	Panel review meeting
No later than July 7, 2017	The CIE Chair submits a draft Summary Report to the contractor for each of the independent reviewers to review and comment
July 17, 2017	Contractor receives draft independent peer review reports as well as the reviewed draft Summary Report
July 31, 2017	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards:

(1) The reports shall be completed in accordance with the required formatting and content (2) The reports shall address each TOR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $10,000.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

NMFS Project Contact:

Dale Sweetnam

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Southwest Fisheries Science Center
National Marine Fisheries Service
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Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs.

   a. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each TOR even if these were consistent with those of other panelists, but especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each TOR, and shall not simply repeat the contents of the summary report.

3. The report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of this Statement of Work
   Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Terms of Reference for the Peer Review

Status of common thresher sharks, Alopias vulpinus, along the west coast of North America

1. Evaluate the assessment model configuration, assumptions, and input parameters (e.g., natural mortality, spawner-recruit relationship, reproductive biology) to determine if the data are properly used, input parameters are reasonable, models are appropriately configured, assumptions are reasonably satisfied, and primary sources of uncertainty are accounted for.
2. Evaluate the ability of the model, combined with available data, to assess the current status and productivity of common thresher sharks along the west coast of North America.
3. Evaluate the adequacy of sensitivity analyses to represent the main axes of uncertainty in the assessment.
4. Recommendations for future research priorities and further improvements to the assessment model.
5. Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations.

Tentative AGENDA

2017 Common Thresher Shark (*Alopias vulpinus*)

Stock Assessment Review

Southwest Fisheries Science Center

8901 La Jolla Shores Dr., La Jolla, CA 92037

La Jolla, CA 92037

858-546-7000

This is a public meeting, and time for public comment may be provided at the discretion of the meeting Chair. This is a work session for the primary purpose of reviewing the current Common Thresher stock assessment, under the Center for Independent Experts terms of reference (ToR). The Stock Assessment Review Panel will review the assessment and produce independent reports and in conjunction with the Chair. The Stock Assessment Team (STAT) will provide presentations and all appropriate background information needed for the review.

MONDAY, JUNE 26, 2017 – 10 A.M.

A. Call to Order, Introductions, Approval of Agenda Chair, TBD
(10 a.m., 15 minutes)

B. Terms of Reference for Stock Assessment Review Process Dale Sweetnam
(10:15 a.m., 15 minutes)

C. Common Thresher Stock Assessment Steve Teo, STAT
(10:30 a.m., 1.5 hours)

LUNCH

D. Common Thresher Stock Assessment (Continued) Steve Teo, STAT
(1 p.m., 2 hours)

BREAK

E. Discussion and Requests Panel
(3:30 p.m., 1 hour)

F. ***Public Comment***
(4:30 p.m., 0.5 hours)

TUESDAY, JUNE 27, 2017 – 8 A.M.

G. Response to Requests Steve Teo, STAT
(8:00 a.m., 2 hours)

BREAK

H. Initial Report Writing and STAT Work Session Panel
(10 a.m., 2 hours)

LUNCH

I. Discussion and Requests
(1:30 p.m., 1 hour)

J. Public Comment
(2:30 p.m., 0.5 hours)

BREAK

K. Report Writing and STAT Work Session Panel
(3:30 p.m., 2 hours)

WEDNESDAY, JUNE 28, 2017

L. Response to Requests Steve Teo, STAT
(8 a.m., 2 hours)

BREAK

M. Discussion and Requests Panel
(10:30 a.m., 1.5 hours)

LUNCH

N. Response to Requests Steve Teo, STAT
(1 p.m., 1 hour)

O. Public Comment
(2 p.m., 0.5 hours)

BREAK

P. Discussion – Next Steps and Deadlines
(3 p.m., 1 hours)

Q. Finalize Report Assignments Chair
(4 p.m., 1 hours)

R. Work Session as Necessary and Meeting Wrap Up Chair
(5 p.m.)

ADJOURN

Appendix 3: Panel membership

Name	Organization	Country
Suzanne Kohin	SWFSC	USA
Henrik Sparholt (Chair)	CIE	Denmark
Joseph Powers	CIE	USA
Rui Coelho	CIE	Portugal
Kevin Hill	SWFSC	USA
P.R. Crone	SWFSC	USA
Heidi Dewar	SWFSC	USA
Hui-Hua Lee	SWFSC	USA
Steven Teo	SWFSC	USA